CLAIMS:

1. A 2 x 2 wireless local area network, comprising:

a first and a second single input single output (SISO) system respectively having a first and second transmitter antenna that transmit a first and second transmitted signal s_1 and s_2;

a first and second receiver antenna that receive a first and second received signal r_1 and r_2; and

a demapping and signal separation module that employs zero forcing (ZF) to guide maximum likelihood (ML) decoding and is connected to said first and second SISO system and is adapted to process said first and second received signal,

wherein a data transmission rate of the 2 x 2 system is greater than 100Mbps at a bit error rate of 10^{-4} and a computation cost for decoding on the order of the decoding cost for an optimal SISO system.

2. The 2 x 2 system of claim 1, wherein the demapping and signal separation module employs zero forcing (ZF) of the first and second received signal, respectively, which received signals correspond to

$$\begin{pmatrix} r_1 \\ r_2 \end{pmatrix} = \begin{pmatrix} h_{11} & h_{21} \\ h_{12} & h_{22} \end{pmatrix} \begin{pmatrix} s_1 \\ s_2 \end{pmatrix} + \begin{pmatrix} n_1 \\ n_2 \end{pmatrix}$$

and results in the first and second transmitted signal being calculated as

$$\begin{pmatrix} \tilde{s}_1 \\ \tilde{s}_2 \end{pmatrix} = \begin{pmatrix} h_{11} & h_{21} \\ h_{12} & h_{22} \end{pmatrix}^{-1} \begin{pmatrix} r_1 \\ r_2 \end{pmatrix}$$

and finds the minimum Euclidean distance between the ZF calculated symbol and a constellation point to estimate by hard decision the first and second transmitted signal as first and second estimated signal as $\begin{pmatrix} \hat{s}_1 \\ \hat{s}_2 \end{pmatrix}$ which are then used to guide the maximum likelihood (ML) decoding,

wherein, h_{ij} represents a channel from the i^{th} transmitter antenna to the j^{th} receiver antenna and n_i are noise signals for $i,j=1,2$.

3. The 2 x 2 system of claim 2, wherein respective bit metrics calculated for first and second transmitted signal s_1 and s_2 are calculated using $\begin{pmatrix} \hat{s}_1 \\ \hat{s}_2 \end{pmatrix}$ as follows for s_1

$$m_{1i}^0 = \min_{s_m \in S^0}((|r_1 - h_{11}s_m - h_{21}\hat{s}_2|^2 + |r_2 - h_{12}s_m - h_{22}\hat{s}_2|^2)|b_{1i} = 0)$$

$$m_{1i}^{1} = \min_{s_m \in S^1}((|\, r_1 - h_{11}s_m - h_{21}\hat{s}_2\,|^2 + |\, r_2 - h_{12}s_m - h_{22}\hat{s}_2\,|^2)|b_{1i} = 1)$$

and for s_2

$$m_{2i}^{0} = \min_{s_n \in S^0}((|\, r_1 - h_{11}\hat{s}_1 - h_{21}s_n\,|^2 + |\, r_2 - h_{12}\hat{s}_1 - h_{22}s_n\,|^2)|b_{2i} = 0)$$

$$m_{2i}^{1} = \min_{s_n \in S^1}((|\, r_1 - h_{11}\hat{s}_1 - h_{21}s_n\,|^2 + |\, r_2 - h_{12}\hat{s}_1 - h_{22}s_n\,|^2)|b_{2i} = 1)$$

and the bit metrics pairs (m_{1i}^0, m_{1i}^1) (m_{2i}^0, m_{2i}^1) are sent to a respective first and second deinterleaver and a first and secondViterbi decoder for decoding,

wherein b_{1i} and b_{2i} respectively is a bit in signal s_1 and s_2 for which a decision is being made.

4. The 2x2 system of claim 2, wherein the demapping and signal separation module obtains a first and second constellation point, s_{1i}^p and s_{2i}^p, satisfying the minimum Euclidean distance from first and second transmitted signal $\tilde{s}_1$ and $\tilde{s}_2$ for bit i

$$\min_{s \in S_i^p} \|\, \tilde{s}_q - s \,\|^2$$

where $q = 1, 2$ and S_i^p represents the subset of a constellation point set for bit i, the bit for which a decision is being made, such that $p \in \{0,1\}$, uses these constellation points as input to a maximum likelihood calculation in the form of a bit metrics calculation for p=0,1

$$m_{1i}^{p} = (\|\, r_1 - h_{11}s_{1i}^{p} - h_{21}\hat{s}_2\,\|^2 + \|\, r_2 - h_{12}s_{1i}^{p} - h_{22}\hat{s}_2\,\|^2)$$
$$m_{2i}^{p} = (\|\, r_1 - h_{11}\hat{s}_1 - h_{21}s_{2i}^{p}\,\|^2 + \|\, r_2 - h_{12}\hat{s}_1 - h_{22}s_{2i}^{p}\,\|^2)$$

and the bit metrics pairs (m_{1i}^0, m_{1i}^1) (m_{2i}^0, m_{2i}^1) are sent to a respective first and second deinterleaver and a first and second Viterbi decoder for decoding.

5. The 2x2 system of claim 2, wherein the demapping and signal separation module performs a slice-compare-select operation to determine a first and second constellation point, s_{1i}^p and s_{2i}^p, corresponding to the ZF signal which first and second constellation point is used as input to a maximum likelihood calculation in the form of a bit metrics calculation for p=0,1

$$m_{1i}^{p} = (\| r_1 - h_{11}s_{1i}^{p} - h_{21}\hat{s}_2 \|^2 + \| r_2 - h_{12}s_{1i}^{p} - h_{22}\hat{s}_2 \|^2)$$
$$m_{2i}^{p} = (\| r_1 - h_{11}\hat{s}_1 - h_{21}s_{2i}^{p} \|^2 + \| r_2 - h_{12}\hat{s}_1 - h_{22}s_{2i}^{p} \|^2)$$

and the bit metrics pairs (m_{1i}^0, m_{1i}^1) (m_{2i}^0, m_{2i}^1) are sent to a respective first and second deinterleaver and a first and second Viterbi decoder for decoding.

6. The 2 x 2 system of claim 1, wherein said first and second SISO system is based on a 54Mbps IEEE 802.11a SISO orthogonal frequency division multiplexing (OFDM) system.

7. A decoder for a 2 x 2 coded orthogonal frequency division multiplexing-multiple input multiple output (COFDM-MIMO) system, comprising:

a demapping and signal separation module to develop a first and second bit metrics pair based on zero forcing guided maximum likelihood (ML) decoding of a first and second received signal r_1 and r_2 that correspond to a first and second transmitted signal s_1 and s_2 respectively transmitted and received by said 2 x 2 COFDM-MIMO system; and

a first and second deinterleaver and Viterbi decoder adapted to receive said first and second bit metrics pairs, respectively, for forward error correction decoding thereof, wherein said decoder enables a transmission rate that is double the transmission rate of an optimal 54Mbps SISO system to 108Mbps at a decoding computation cost comparable to that of the optimal 54Mbps SISO system.

8. The decoder of claim 7, wherein the demapping and signal separation module employs zero forcing (ZF) of the first and second received signal, respectively, which received signals correspond to

$$\begin{pmatrix} r_1 \\ r_2 \end{pmatrix} = \begin{pmatrix} h_{11} & h_{21} \\ h_{12} & h_{22} \end{pmatrix} \begin{pmatrix} s_1 \\ s_2 \end{pmatrix} + \begin{pmatrix} n_1 \\ n_2 \end{pmatrix}$$

and results in the first and second transmitted signal being calculated as

$$\begin{pmatrix} \tilde{s}_1 \\ \tilde{s}_2 \end{pmatrix} = \begin{pmatrix} h_{11} & h_{21} \\ h_{12} & h_{22} \end{pmatrix}^{-1} \begin{pmatrix} r_1 \\ r_2 \end{pmatrix}$$

and finds the minimum Euclidean distance between the ZF calculated symbol and a constellation point to estimate by hard decision the first and second transmitted signal as first and second estimated signal as $\begin{pmatrix} \hat{s}_1 \\ \hat{s}_2 \end{pmatrix}$ which are then used to guide the maximum likelihood (ML) decoding,

wherein, h_{ij} represents a channel from the i^{th} transmitter antenna to the j^{th} receiver antenna and n_i are noise signals for i,j=1,2.

9. The decoder of claim 8, wherein the demapping and signal separation module (34) calculates respective bit metrics for first and second transmitted signal s_1 and s_2 using $\binom{\hat{s}_1}{\hat{s}_2}$ as follows for s_1

$$m_{1i}^0 = \min_{s_m \in S^0}((|r_1 - h_{11}s_m - h_{21}\hat{s}_2|^2 + |r_2 - h_{12}s_m - h_{22}\hat{s}_2|^2)|b_{1i} = 0)$$

$$m_{1i}^1 = \min_{s_m \in S^1}((|r_1 - h_{11}s_m - h_{21}\hat{s}_2|^2 + |r_2 - h_{12}s_m - h_{22}\hat{s}_2|^2)|b_{1i} = 1)$$

and for s_2

$$m_{2i}^0 = \min_{s_n \in S^0}((|r_1 - h_{11}\hat{s}_1 - h_{21}s_n|^2 + |r_2 - h_{12}\hat{s}_1 - h_{22}s_n|^2)|b_{2i} = 0)$$

$$m_{2i}^1 = \min_{s_n \in S^1}((|r_1 - h_{11}\hat{s}_1 - h_{21}s_n|^2 + |r_2 - h_{12}\hat{s}_1 - h_{22}s_n|^2)|b_{2i} = 1)$$

wherein b_{1i} and b_{2i} respectively is a bit in signal s_1 and s_2 for which a decision is being made.

10. The decoder of claim 8, wherein the demapping and signal separation module obtains a first and second constellation point, s_{1i}^p and s_{2i}^p, satisfying the minimum Euclidean distance from first and second transmitted signal $\tilde{s}_1$ and $\tilde{s}_2$ for bit i

$$\min_{s \in S_i^p} \| \tilde{s}_q - s \|^2 .$$

and uses these constellation points as input to a maximum likelihood calculation in the form of a bit metrics calculation for p=0,1

$$m_{1i}^p = (\| r_1 - h_{11}s_{1i}^p - h_{21}\hat{s}_2 \|^2 + \| r_2 - h_{12}s_{1i}^p - h_{22}\hat{s}_2 \|^2)$$
$$m_{2i}^p = (\| r_1 - h_{11}\hat{s}_1 - h_{21}s_{2i}^p \|^2 + \| r_2 - h_{12}\hat{s}_1 - h_{22}s_{2i}^p \|^2)$$

wherein, $q = 1, 2$ and S_i^p represents the subset of a constellation point set for bit i such that $p \in \{0,1\}$, and bit i is the bit for which a decision is being made.

11. The decoder of claim 8, wherein the demapping and signal separation module performs a slice-compare-select operation to determine a first and second

constellation point, s_{1i}^{p} and s_{2i}^{p}, corresponding to the ZF signal which are then used as input to a maximum likelihood calculation in the form of a bit metrics calculation for p=0,1

$$m_{1i}^{p} = (\| r_1 - h_{11}s_{1i}^{p} - h_{21}\hat{s}_2 \|^2 + \| r_2 - h_{12}s_{1i}^{p} - h_{22}\hat{s}_2 \|^2)$$
$$m_{2i}^{p} = (\| r_1 - h_{11}\hat{s}_1 - h_{21}s_{2i}^{p} \|^2 + \| r_2 - h_{12}\hat{s}_1 - h_{22}s_{2i}^{p} \|^2).$$

12. A decoding method for a 2 x 2 coded orthogonal frequency division multiplexing multiple input multiple output system, comprising the steps of:

transmitting by said 2 x 2 system a first and second transmitted signal;

receiving by said 2 x 2 system a first and second received signal that correspond to said first and second transmitted signal;

developing a first and second bit metrics pair based on zero forcing guided maximum likelihood (ML) decoding of said first and second received signal; and

deinterleaving and decoding said first and second bit metrics pairs to obtain a first and second decoded signal,

wherein said decoder enables a transmission rate that is double the transmission rate of an optimal 54 Mbps single input single output SISO system to 108Mbps at a decoding computation cost comparable to that of the optimal 54 Mbps SISO system.

13. The decoding method of claim 12, wherein said developing step further comprises the steps of:

separating the first and second received signal into a first and second separated signal;

obtaining by hard decision a first and a second constellation point which is respectively closest to the first and second separated symbol;

with the second constellation point fixed, calculating the first bit metrics pair using ML criteria and the first separated signal; and

with the first constellation point fixed, calculating the second bit metrics pair using ML criteria.

14. The decoding method of claim 12, wherein said developing step further comprises the steps of:

separating the first and second received signal into a first and second separated signal;

obtaining a first and second constellation point which satisfies the minimum Euclidean distance from the first and second separated signal; and

calculating a first and second bit metrics pair using the first and second constellation point as input to a maximum likelihood calculation.

15. The decoding method of claim 12, wherein said developing step further comprises the steps of:

separating the first and second received signal into a first and second separated signal;

obtaining a first and second constellation point corresponding to the separated signal by a slice-compare-select operation; and

calculating a first and second bit metrics pair using the first and second constellation point as input to a maximum likelihood calculation.